1.4 Surface Acoustic Wave Mercury Vapor Sensor

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Abstract

The goal of this project is to develop a fast, simple, inexpensive and reliable sensor-based instrument for detecting and monitoring to low (less than 5 µg/dscm) levels of mercury emissions. The instrument was designed to be site deployable and to provide continuous data on cumulative mercury exposure and instantaneous concentration.

The underlying sensing mechanism for gaseous mercury is based upon surface acoustic wave (SAW) technology with a thin gold film used as an ultrasensitive microbalance. By coating the delay line with a thin gold film and configuring it as an RF oscillator, mass changes in the film can be measured by monitoring the oscillation frequency. The oscillation frequency then becomes a direct measure of the instantaneous mercury concentration. The sensor is reusable since the mercury can be driven from the film by heating it to a high temperature. A second SAW delay line without a sensing film can, if necessary, be incorporated into the device to act as a reference so that extraneous environmental effects which perturb both delay lines equally can be subtracted out.

In order to develop the necessary knowledge base required of a commercially viable SAW based mercury vapor sensor, a number of important technical objectives had to be accomplished. These included (i) the development of a heater element to optimize the sorption and desorption of mercury vapor on the gold sensing film, (ii) the determination of the optimum gold film thickness and operating temperature for the sensing element, (iii) the characterization of the SAW sensor response signature, (iv) the determination of the sensor selectivity, (v) the effect of potential interferences, (vi) the fabrication of a field deployable prototype instrument, (vii) extensive laboratory testing of the sensor instrument, and (viii) field testing and demonstration of the sensor instrument. This presentation will discuss recent work, including the results of the Field Test performed earlier this year using the gas sampling and preconditioning system at the University of North Dakota, Energy and Environmental Research Center (EERC).